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(54) IMPROVEMENTS RELATING TO WIND TURBINES

VERBESSERUNGEN AN WINDTURBINEN

AMÉLIORATIONS CONCERNANT DES TURBINES ÉOLIENNES

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EP 2 859 220 B1

Description

Technical Field

[0001] This invention relates to wind turbines.

Background

[0002] A typical wind turbine 10 is shown schematically in Figure 1 of the drawings. It comprises a tower 11, a nacelle 12 mounted to the top of the tower 11 and a rotor assembly 13 mounted to an upwind end 14 of the nacelle 12.

[0003] The rotor assembly 13 comprises blades 15 mounted on a central hollow hub 16. Typically there are three blades but there could be two blades or four or more blades. The blades 15 turn with the hub 16 in a rotor plane to drive a generator within the nacelle 12 to produce electricity.

[0004] The nacelle 12 can turn relative to the tower 11, the hub 16 can turn relative to the nacelle 12 and the blades 15 can turn relative to the hub 16. Specifically:

the nacelle 12 turns about a generally vertical yaw axis 17 with respect to the tower 11 to keep the rotor plane substantially orthogonal to the wind direction;

when driven by the wind, the rotor turns about a near-horizontal rotor axis 18 with respect to the nacelle 12; and

to adjust their angle of attack, each blade 15 can be turned with respect to the hub 16 about a pitch axis 19 that extends radially from the rotor axis 18 along a centre line of the blade root 20, when viewed along the rotor axis 18.

[0005] As the blades 15 will bend in a downwind direction under wind forces, measures may be necessary to avoid any risk of the lowest blade of the rotor 13 striking the tower 11 in extremis. Firstly, the rotor axis 18 is typically set a few degrees above the horizontal 21. Secondly, the blades 15 commonly have a negative cone angle with respect to the hub 16 as shown, i.e. the blades 15 are inclined in a slightly upwind direction moving radially outward from the hub 16. The cone angle is exaggerated in Figure 1, and in reality would typically only be a few degrees at most. Thus, whilst the pitch axis 19 extends radially from the rotor axis 18 when viewed along the rotor axis 18, the pitch axis 19 is not orthogonal to the rotor axis 18: the rotor plane is only approximately planar.

[0006] Various annular bearings enable the movements of the nacelle 12, the hub 16 and the blades 15. Specifically:

a yaw bearing between the tower 11 and the nacelle 12 lies in a substantially horizontal plane;

a rotor bearing between the hub 16 and the nacelle 12 lies in a near-vertical plane orthogonal to the rotor axis 18; and

a pitch bearing between each blade root 20 and the hub 16 lies in a plane orthogonal to the pitch axis 19.

[0007] Typically, a generally circular hub plate extends across each blade bearing. The hub plates are primarily stiffening bulkheads of the hub 16 but may also serve as work platforms for technicians working within the stationary hub during installation and maintenance of the wind turbine. In particular, a hub plate may serve as a work platform when the blade 15 associated with that hub plate is parked to hang downwardly from the hub in alignment with the tower. A downwardly-hanging blade 15a is shown in Figure 2.

[0008] It is known in the prior art for each hub plate to lie in a plane parallel to the associated blade bearing and thus orthogonal to the pitch axis 19 (Figure 1). However, the pitch axis 19 of the downwardly-hanging blade may depart significantly from the vertical: individually and especially in combination, the inclined rotor axis 18 and the cone angle tend to tilt the pitch axis 19 of that downwardly-hanging blade in the upwind direction, away from the tower 11, as shown in Figure 1. Consequently, a hub plate may be inclined too far from the horizontal to make an ideal work platform. DE 202004003521 U1 and EP 1930584 A2 provide examples of a wind turbine hub.

Summary of the invention

[0009] Against this background, the invention resides in a wind turbine as defined in claim 1. The plane of the work platform is preferably substantially parallel to the horizontal plane. However, angles of up to approximately seven degrees may be acceptable. In a particular embodiment described in detail later, the work platform is inclined at approximately five degrees to the horizontal. Angles between zero and five degrees are considered preferable. When the wind turbine blade is parked in a downwardly direction in alignment with the tower, the work platform provides a convenient platform for maintenance personnel to use when installing or servicing components in or around the hub. The work platform preferably includes one or more manholes for providing access between the hub and the blade.

[0010] The rotor axis of the wind turbine is typically inclined upwardly relative to the horizontal plane by an angle of approximately eleven degrees. In order to be substantially horizontal when the blade is parked in a downwardly direction (as shown in Figure 2), the work platform may be suitably inclined inwardly with respect to the hub moving parallel to the rotor axis in a direction from the hub towards the nacelle.

[0011] The hub plate preferably comprises a substantially circular outer flange for connecting the hub plate to the hub. The outer flange suitably lies in a plane parallel

to the bearing plane. Accordingly, the work platform is inclined relative to the plane of the outer flange. In preferred embodiments of the invention, the outer flange is mounted between the hub and the pitch bearing. The pitch bearing preferably comprises an inner ring and an outer ring and the outer flange is preferably mounted to the inner ring. Accordingly, the blade is preferably mounted to the outer ring. It will however be appreciated that the hub plate may be mounted to the outer ring and the blade mounted to the inner ring in other embodiments.

[0012] The hub plate may comprise a peripheral sidewall between the work platform and the outer flange. The profile of the sidewall preferably varies about the periphery of the work platform in accordance with the inclination of the work platform relative to the outer flange. In a preferred embodiment of the invention, the peripheral sidewall extends generally towards the rotor blade on an inboard side of the work platform nearest the nacelle and extends generally towards the hub on an outboard side of the platform furthest from the nacelle. This configuration can advantageously result in a relatively compact configuration because it allows the work platform to be contained largely within a cylindrical region defined by an inner circumference of the pitch bearing. A majority of the work platform is contained within a cylindrical space defined by an inner circumference of the annular pitch bearing and bound by a pair of opposed planes defined respectively by upper and lower faces of the annular pitch bearing. For the avoidance of doubt, 'a majority' of the work platform may include all of the work platform.

[0013] The inventive concept includes a wind farm comprising a plurality of wind turbines as described above.

[0014] The inventive concept also includes a hub plate for a wind turbine, as defined in claim 12.

Brief description of the drawings

[0015] Figures 1 and 2, which are, respectively, schematic side and front views of a wind turbine, have already been described above by way of background to the invention.

[0016] In order that the invention may be more readily understood, reference will now be made, by way of non-limiting example only, to the following drawings, in which:

Figure 3 is a partial cross-section through a hub of a wind turbine according to the present invention, showing hub plates connected between the hub and respective wind turbine blades;

Figure 3A is an enlarged view of the part of Figure 3 within the dashed box in Figure 3;

Figure 4 is a front view of one of the hub plates shown in Figure 3;

Figure 5 is a rear view of the hub plate of Figure 4; and

Figure 6 shows a pitch bearing and elements of a hydraulic pitch mechanism mounted to the hub plate.

Detailed description

[0017] Referring initially to Figure 3, which shows a hub 30 of a wind turbine according to the present invention, three blades are connected to the hub 30, but only two blades 32a and 32b are visible in the partial cross-sectional view of Figure 3. Hub plates 34, in the form of stiffening bulkheads, are mounted at the interface between the hub 30 and the respective blades 32a, 32b. The hub plates 34 are generally circular and have a front face 36 that faces the hub 30 and a rear face 38 that faces the respective blade 32a, 32b. The front face 36 is shown more clearly in Figure 4 and the rear face 38 is shown more clearly in Figure 5.

[0018] Referring to the lower blade 32a shown in Figure 3, an annular pitch bearing 40 is mounted between the hub plate 34 and the blade 32a. Whilst not shown in Figure 3, a similar pitch bearing is provided between the respective hub plates and blades of the other two blades. The pitch bearing 40 is shown more clearly in Figure 3A, which is an enlarged view of the part of Figure 3 within the dashed box 42.

[0019] Referring to Figure 3A, the pitch bearing 40 comprises an inner ring 44 and an outer ring 45, with two series of balls 46 provided in-between. The hub plate 34 is mounted between the hub 30 and the inner ring 44, and this assembly is fixed in place by a plurality of bolts 48 and associated nuts. The bolts 48 are received in a series of circularly arranged, and mutually aligned holes 49 provided in the hub 30, the hub plate 34 and the inner ring 44 respectively. The series of holes 49 in the hub plate 34 are provided in a circular outer flange 50 of the hub plate 34, as shown more clearly in Figures 4 and 5. Referring still to Figure 3A, a root end 52 of the blade 32a is secured to the outer ring 45 of the pitch bearing 40 by a plurality of pins/bolts 54, which are received in a series of circularly arranged, and mutually aligned holes provided in the root end 52 of the blade 32a and the outer ring 45 of the pitch bearing 40.

[0020] Referring to Figure 3 to 5, the hub plate 34 comprises a central, substantially circular and flat work platform 56. The work platform 56 includes a manhole 58a, which provide service access to the interior of the hub 30 or blade 32a for maintenance personnel. The work platform 56 is surrounded by a circumferential sidewall 60. The circumferential sidewall 60 extends between the work platform 56 and the outer circular flange 50 of the hub plate 34, as shown best in Figures 4 and 5. The work platform 56 and the outer circular flange 50 are formed as a single casting of steel.

[0021] The work platform 56 of the hub plate 34 in this example is inclined relative to the plane of the outer circular flange 50, and hence is inclined relative to the plane of the pitch bearing 40 in order that the work platform 56 is substantially horizontal when the blade 32a is parked

in a substantially downward direction, parallel to the tower, as shown in Figure 3. Specifically, the work platform 56 is inclined inwardly with respect to hollow interior of the hub 30 moving parallel to the rotor axis 62 in a direction from the hub 30 towards the nacelle (not shown), as indicated by the arrow 64 in Figure 3.

[0022] In this example, the hub plate 34 is arranged such that the work platform 56 is inclined at approximately five degrees to a horizontal plane 66, as represented by the line 67, when the blade 32a is parked in this position. This level of inclination is considered to be substantially horizontal, and provides a sufficiently level surface for maintenance personnel to stand on when installing or servicing nearby components, such as components of the pitch mechanism.

[0023] The rotor axis 62 is typically inclined at about eleven degrees to the horizontal, so ignoring any additional inclination due to cone angle, it will be appreciated that the work platform 56 of the hub plate 34 is significantly less inclined relative to the horizontal than prior art hub plates, which are arranged in the plane of the pitch bearing 40, and hence are inclined to the horizontal at least by the same amount as the rotor axis 62 when the blade 32a is downwardly extending.

[0024] The profile of the circumferential sidewall 60 varies about the periphery of the work platform 56 in accordance with the inclination of the work platform 56 relative to the plane of the circular outer flange 50. In this example, at an inboard side 68 of the hub plate 34, the sidewall 60 extends generally upwards from the rear face 38 (Figure 5) of the hub plate 34, i.e. generally towards the blade 32a, 32b, whilst at an outboard side 70 of the hub plate 34, the sidewall 50 extends generally upwards from the front face 36 (Figure 4) of the hub plate 34, i.e. towards the hub 30. The terms 'inboard' and 'outboard' are to be understood with respect to a generally vertical yaw axis 17 between the nacelle and the tower, as shown in Figure 1. This configuration is advantageous because it results in a relatively compact hub plate 34, with a majority of the work platform 56 being accommodated within a cylindrical space 72 defined by an inner circumference of the annular pitch bearing 40 and bound by a pair of opposed planes 73, 74 defined respectively by upper and lower faces of the annular pitch bearing 40, as shown in Figure 3.

[0025] Referring to Figure 6, this shows the pitch bearing 40 mounted to the circular outer flange 50 (Figure 5) of the hub plate 34. Figure 6 also shows a pair of hydraulic actuators 76 of the pitch mechanism. The actuators 76 each include a piston 77 and a cylinder 78. The cylinders 78 of the respective actuators 76 are attached to mounting points 79 on the hub plate 34 respectively via a pair of brackets 80. The respective pistons 77 are connected to a crossbar 82 of a coupling ring 83, to which the blade 32a is attached. As is known in the art, the blade 32a is caused to turn about its pitch axis by extending one of the pistons 77 relative to its cylinder 78 and lengthening the other piston 77 relative to its cylinder 78.

[0026] Various modifications may be made to the present invention without departing from the scope of the invention as defined by the following claims. For example, it will be appreciated that the sidewall 60 of the hub plate 34 may be configured differently in other embodiments. For example, at the outboard side 70 of the hub plate 34 the sidewall 60 could be very shallow or non-existent. This would require the sidewall 60 at the inboard side 68 of the hub plate 34 to be deeper. This in turn would result in the work platform 56 protruding significantly from the inner cylindrical space 72 defined by the pitch bearing 40.

[0027] Whilst in the present invention the work platform 56 also serves as a stiffening bulkhead, in yet further embodiments a separate work platform may be attached to the hub plate. In such examples, the hub plate may resemble a prior art hub plate, i.e. in which the plate is substantially parallel to the plane of the pitch bearing, but this hub plate could have an additional work platform attached, which is configured to be substantially horizontal when the blade is parked downwardly.

Claims

1. A wind turbine (10) comprising:

a tower (11);
a nacelle (12) mounted to the top of the tower;
a rotor (13) mounted to the nacelle, the rotor comprising two or more blades (32a, 32b) mounted to a central hub (16), the hub supporting two or more annular pitch bearings (40) associated respectively with the two or more blades, each pitch bearing defining a bearing plane inclined at a first angle with respect to a horizontal plane when the respective blade is oriented in a downwardly direction in alignment with the tower, wherein: each pitch bearing is spanned by a hub plate (34); and a work platform (56) integral with or mounted to the hub plate lies generally in a plane at a second angle to the horizontal plane when the respective blade is oriented in said downwardly direction in alignment with the tower, which second angle is less than the first angle, **characterized in that** a majority of the work platform is contained within a cylindrical space defined by an inner circumference of the annular pitch bearing and bound by a pair of opposed planes defined respectively by upper and lower faces of the annular pitch bearing.

2. A wind turbine as claimed in Claim 1, wherein the plane of the work platform lies substantially parallel to the horizontal plane.

3. A wind turbine as defined in Claim 1 or Claim 2,

wherein the second angle is approximately five degrees or less.

4. A wind turbine as claimed in any preceding claim, wherein the work platform is inclined inwardly with respect to the hub moving parallel to a rotor axis (62) of the wind turbine in a direction from the hub towards the nacelle.

5. A wind turbine as claimed in any preceding claim, wherein the hub plate comprises a substantially circular outer flange (50) for connecting the hub plate to the hub, the outer flange lying in a plane parallel to the bearing plane.

6. A wind turbine as claimed in Claim 5, wherein the outer flange is mounted between the hub and the pitch bearing.

7. A wind turbine as claimed in Claim 6, wherein the pitch bearing comprises an inner ring (44) and an outer ring (45) and the outer flange is mounted to the inner ring.

8. A wind turbine as claimed in any of Claims 5 to 7, wherein the hub plate comprises a peripheral sidewall between the work platform and the outer flange.

9. A wind turbine as claimed in Claim 8, wherein the profile of the sidewall varies about the periphery of the work platform in accordance with the inclination of the work platform relative to the outer flange.

10. A wind turbine as claimed in Claim 9, wherein the peripheral sidewall extends towards the rotor blade on an inboard side of the work platform nearest the nacelle and extends towards the hub on an outboard side of the platform furthest from the nacelle.

11. A wind farm comprising a plurality of wind turbines (10) as claimed in any preceding claim.

12. A hub plate (34) for a wind turbine (10), the hub plate comprising:

a work platform (56) defining a first plane; and
a substantially circular outer flange (50) at least partially surrounding the work platform, the outer flange defining a second plane and providing a means for mounting the hub plate to a hub of the wind turbine at an interface between the hub and a rotor blade;
wherein the first plane is inclined relative to the second plane, wherein the hub plate is mounted to an annular pitch bearing (40), wherein a majority of the work platform is contained within a cylindrical space defined by an inner circumference of the annular pitch bearing and bound by a pair of opposed planes defined respectively by upper and lower faces of the annular pitch bearing.

13. A hub for a wind turbine comprising a hub plate as claimed in Claim 12.

14. A wind turbine comprising a hub as claimed in Claim 13.

Patentansprüche

1. Windturbine (10), umfassend:

einen Turm (11);
eine Gondel (12) montiert auf der Spitze des Turms;
einen Rotor (13) montiert an der Gondel, wobei der Rotor zwei oder mehr Rotorblätter (32a, 32b) umfasst, die an einer zentralen Nabe (16) montiert sind, wobei die Nabe zwei oder mehr ringförmige Pitchlager (40) trägt, die entsprechend mit den zwei oder mehr Rotorblättern assoziiert sind, wobei jedes Pitchlager eine Lagerebene definiert, die unter einem ersten Winkel in Bezug auf eine horizontale Ebene geneigt ist, wenn das entsprechende Rotorblatt in eine Abwärtsrichtung in einer Richtung mit dem Turm orientiert ist, wobei: jedes Pitchlager von einer Nabenplatte (34) umfasst ist; und eine Arbeitsplattform (56), die in die Nabenplatte eingebaut oder an der Nabenplatte montiert ist, im Allgemeinen in einer Ebene unter einem zweiten Winkel zu der horizontalen Ebene liegt, wenn das entsprechende Rotorblatt in der Abwärtsrichtung in Richtung mit dem Turm orientiert ist, wobei der zweite Winkel kleiner als der erste Winkel ist,
dadurch gekennzeichnet, dass

ein Großteil der Arbeitsplattform innerhalb eines zylindrischen Raumes enthalten ist, der mittels eines Innenumfangs des ringförmigen Pitchlagers definiert ist und mittels eines Paares gegenüberliegender Ebenen begrenzt ist, die entsprechend von den oberen und unteren Oberflächen des ringförmigen Pitchlagers definiert sind.

2. Windturbine nach Anspruch 1, wobei die Ebene der Arbeitsplattform im Wesentlichen parallel zu der horizontalen Ebene liegt.

3. Windturbine nach Anspruch 1 oder nach Anspruch 2, wobei der zweite Winkel ungefähr fünf Grad oder weniger ist.

4. Windturbine nach einem der vorhergehenden An-

sprüche, wobei die Arbeitsplattform nach innen geneigt ist in Bezug auf die Nabe, die sich parallel zu einer Rotorachse (62) der Windturbine in einer Richtung von der Nabe abwärts auf die Gondel zu bewegt.

5. Windturbine nach einem der vorhergehenden Ansprüche, wobei die Nabenplatte einen im Wesentlichen kreisförmigen äußeren Flansch (50) zum Verbinden der Nabenplatte mit der Nabe umfasst, wobei der äußere Flansch in einer Ebene parallel zu der Lagerebene liegt.

6. Windturbine nach Anspruch 5, wobei der äußere Flansch zwischen der Nabe und dem Pitchlager montiert ist.

7. Windturbine nach Anspruch 6, wobei das Pitchlager einen Innenring (44) und einen Außenring (45) umfasst und der äußere Flansch an dem Innenring montiert ist.

8. Windturbine nach einem der Ansprüche 5 bis 7, wobei die Nabenplatte eine periphere Seitenwand zwischen der Arbeitsplattform und dem äußeren Flansch umfasst.

9. Windturbine nach Anspruch 8, wobei das Profil der Seitenwand um die Peripherie der Arbeitsplattform in Übereinstimmung mit der Neigung der Arbeitsplattform relativ zu dem äußeren Flansch variiert.

10. Windturbine nach Anspruch 9, wobei die periphere Seitenwand sich in Richtung auf das Rotorblatt auf einer innenliegenden Seite der Arbeitsplattform am nächsten zu der Gondel erstreckt und sich in Richtung auf die Nabe auf einer außenliegenden Seite der Plattform am weitesten von der Gondel entfernt erstreckt.

11. Windenergiepark umfassend eine Vielzahl von Windturbinen (10) nach einem der vorhergehenden Ansprüche.

12. Nabenplatte (34) für eine Windturbine (10), wobei die Nabenplatte umfasst:

eine Arbeitsplattform (56), die eine erste Ebene definiert; und
einen im Wesentlichen kreisförmigen äußeren Flansch (50), der die Arbeitsplattform mindestens teilweise umgibt, wobei der äußere Flansch eine zweite Ebene definiert und Mittel zum Montieren der Nabenplatte an einer Nabe der Windturbine an einer Schnittstelle zwischen der Nabe und einem Rotorblatt bereitstellt;
wobei die erste Ebene relativ zu der zweiten Ebene geneigt ist, wobei die Nabenplatte an einem ringförmigen Pitchlager (40) montiert ist, wobei ein Großteil der Arbeitsplattform innerhalb eines zylindrischen Raumes enthalten ist, der mittels eines Innenumfangs des ringförmigen Pitchlagers definiert ist und mittels eines Paares von gegenüberliegenden Ebenen begrenzt ist, die entsprechend von den oberen und unteren Oberflächen des ringförmigen Pitchlagers definiert sind.

13. Nabe für eine Windturbine, umfassend eine Nabenplatte nach Anspruch 12.

14. Windturbine, umfassend eine Nabe nach Anspruch 13.

Revendications

1. Éolienne (10) comprenant :

une tour (11) ;
une nacelle (12) montée en haut de la tour ;
un rotor (13) monté sur la nacelle, le rotor comprenant deux ou plusieurs pales (32a, 32b) montées sur un moyeu central (16), le moyeu supportant deux ou plusieurs roulements de calage annulaires (40) associés respectivement aux deux ou plusieurs pales, chaque roulement de calage définissant un plan de roulement incliné à un premier angle par rapport à un plan horizontal lorsque la pale respective est orientée dans une direction descendante en alignement avec la tour, dans laquelle : chaque roulement de calage est recouvert par une plaque de moyeu (34) ; et une plateforme de travail (56) intégrée à ou montée sur la plaque de moyeu repose généralement dans un plan à un second angle par rapport au plan horizontal lorsque la pale respective est orientée dans ladite direction descendante en alignement avec la tour, lequel second angle est inférieur au premier angle,
caractérisée en ce qu'une majeure partie de la plateforme de travail est contenue dans un espace cylindrique défini par une circonférence interne du roulement de calage annulaire et délimité par une paire de plans opposés respectivement définis par des faces supérieure et inférieure du roulement de calage annulaire.

2. Éolienne selon la revendication 1, dans laquelle le plan de la plateforme de travail repose sensiblement parallèlement au plan horizontal.

3. Éolienne selon la revendication 1 ou la revendication 2, dans laquelle le second angle est approximativement de cinq degrés ou moins.

4. Éolienne selon n'importe quelle revendication précédente, dans laquelle la plateforme de travail est inclinée vers l'intérieur par rapport au moyeu se déplaçant parallèlement à un axe de rotor (62) de l'éolienne dans une direction allant du moyeu vers la nacelle.

5. Éolienne selon n'importe quelle revendication précédente, dans laquelle la plaque de moyeu comprend une bride externe sensiblement circulaire (50) pour relier la plaque de moyeu au moyeu, la bride externe reposant dans un plan parallèle au plan de roulement.

6. Éolienne selon la revendication 5, dans laquelle la bride externe est montée entre le moyeu et le roulement de calage.

7. Éolienne selon la revendication 6, dans laquelle le roulement de calage comprend une bague interne (44) et une bague externe (45) et la bride externe est montée sur la bague interne.

8. Éolienne selon l'une quelconque des revendications 5 à 7, dans laquelle la plaque de moyeu comprend une paroi latérale périphérique entre la plateforme de travail et la bride externe.

9. Éolienne selon la revendication 8, dans laquelle le profil de la paroi latérale varie autour de la périphérie de la plateforme de travail en fonction de l'inclinaison de la plateforme de travail par rapport à la bride externe.

10. Éolienne selon la revendication 9, dans laquelle la paroi latérale périphérique s'étend vers la pale de rotor sur un côté intérieur de la plateforme de travail le plus proche de la nacelle et s'étend vers le moyeu sur un côté extérieur de la plateforme le plus éloigné de la nacelle.

11. Parc éolien comprenant une pluralité d'éoliennes (10) selon n'importe quelle revendication précédente.

12. Plaque de moyeu (34) pour une éolienne (10), la plaque de moyeu comprenant :

une plateforme de travail (56) définissant un premier plan ; et
une bride externe sensiblement circulaire (50) entourant au moins partiellement la plateforme de travail, la bride externe définissant un second plan et fournissant des moyens pour monter la plaque de moyeu sur un moyeu de l'éolienne au niveau d'une interface entre le moyeu et une pale de rotor ;
dans laquelle le premier plan est incliné par rapport au second plan, dans laquelle la plaque de moyeu est montée sur un roulement de calage annulaire (40), dans laquelle la majeure partie de la plateforme de travail est contenue dans un espace cylindrique défini par une circonférence interne du roulement de calage annulaire et délimité par une paire de plans opposés respectivement définis par des faces supérieure et inférieure du roulement de calage annulaire.

13. Moyeu pour une éolienne comprenant une plaque de moyeu selon la revendication 12.

14. Éolienne comprenant un moyeu selon la revendication 13.

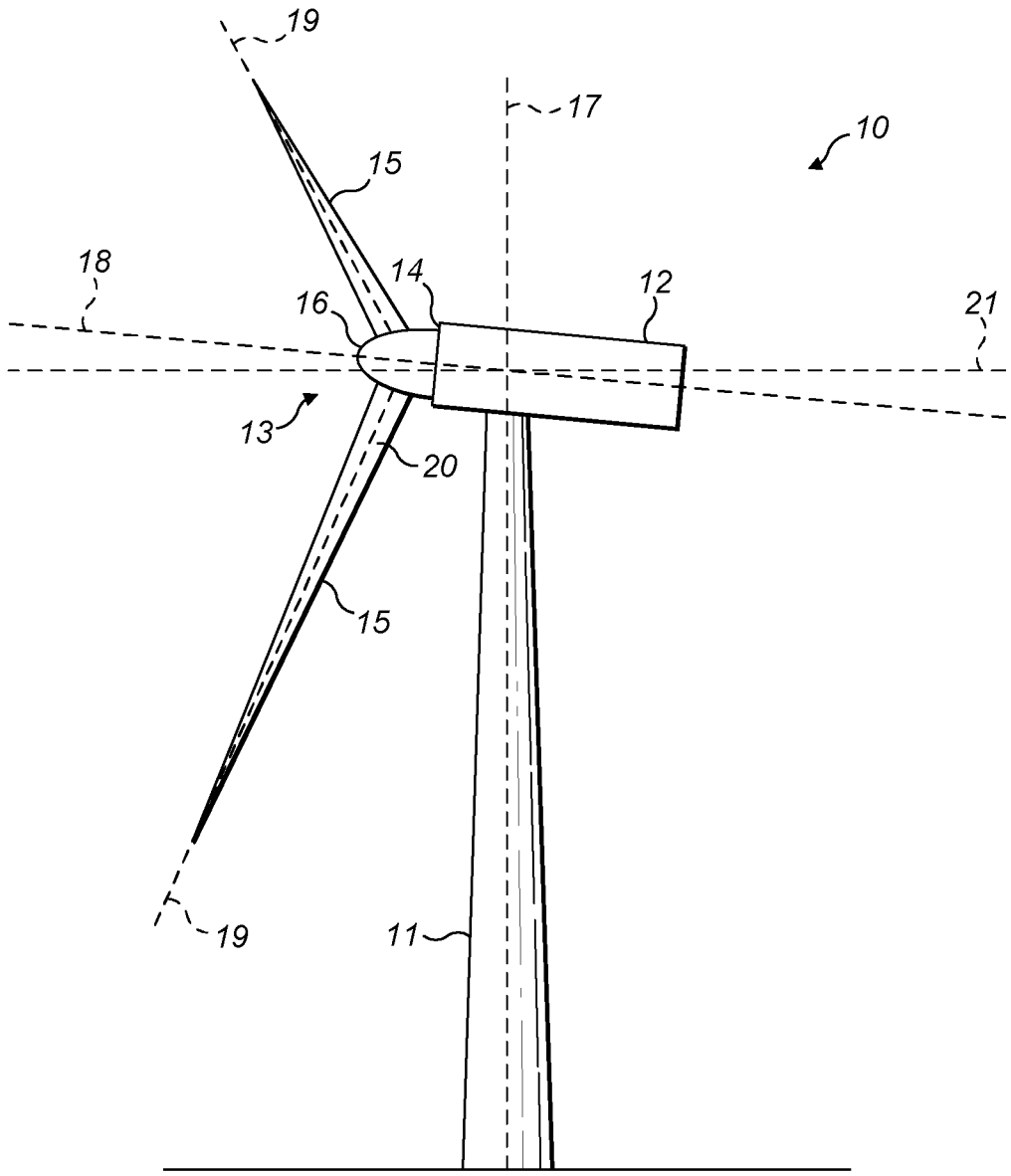

FIG. 1

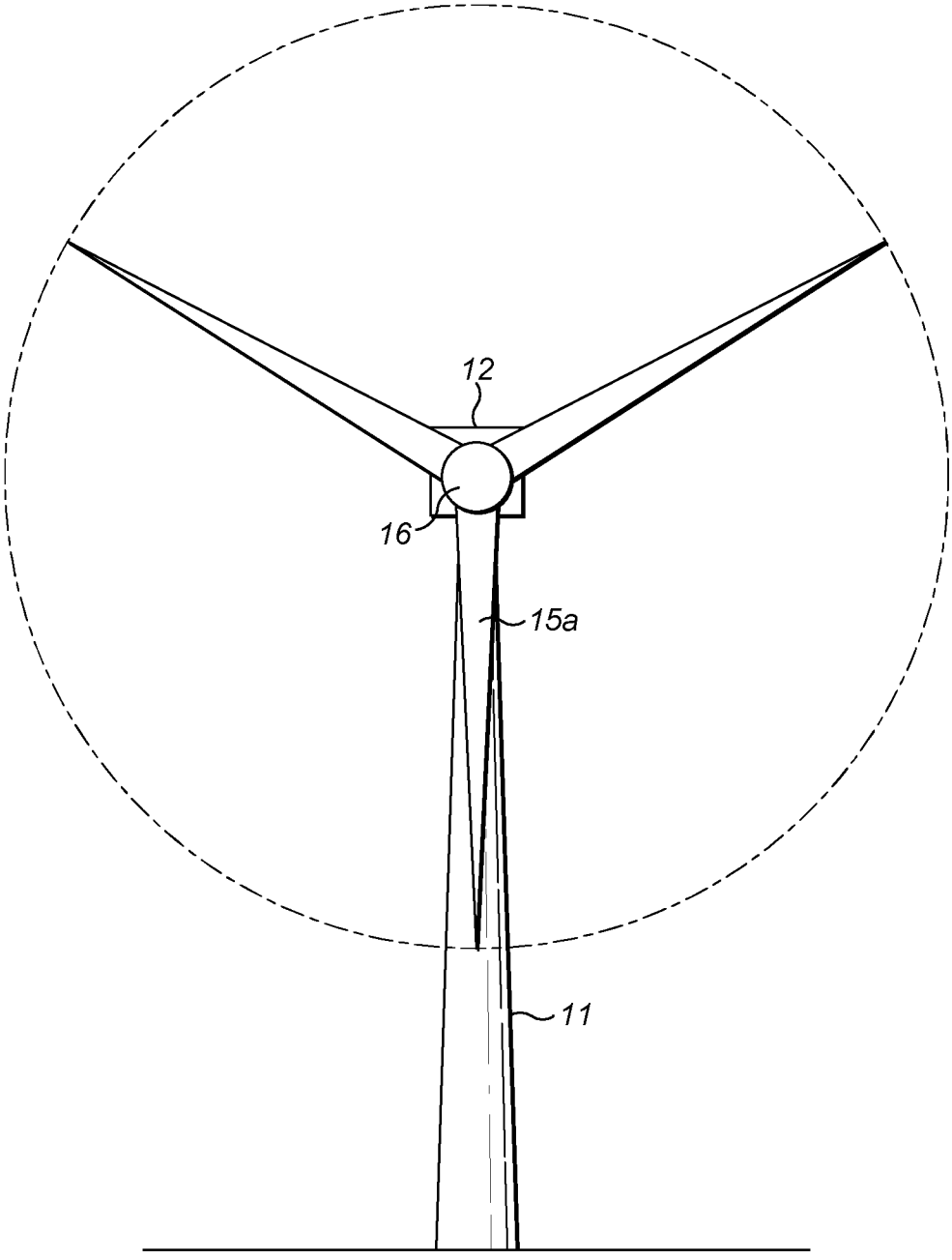

FIG. 2

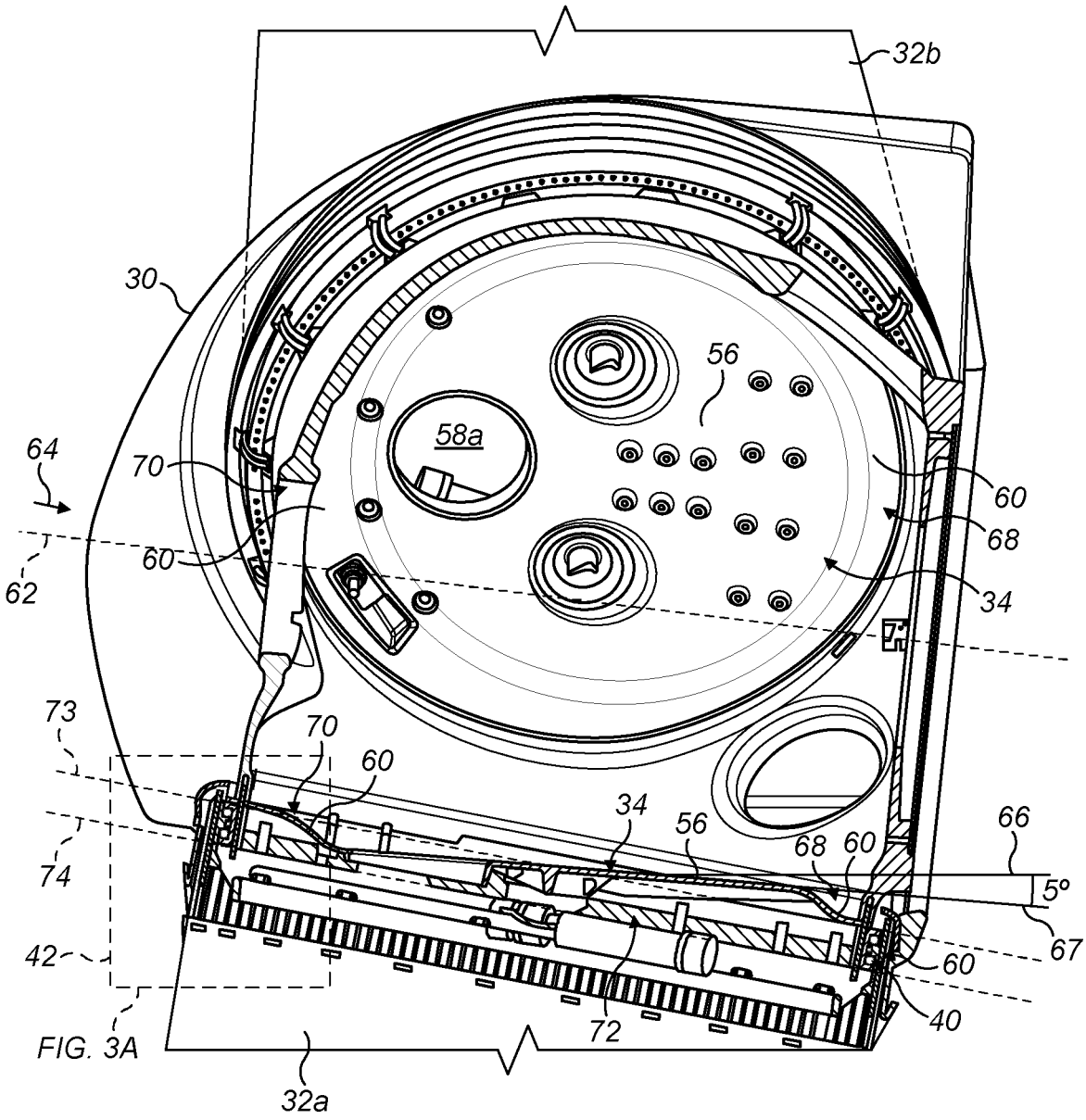
32b
30
56
58a
64
70
60
68
62
60
34
73
70
60
34
56
66
74
68
60
5°
42
67
60
40
72
FIG. 3A
32a

FIG. 3

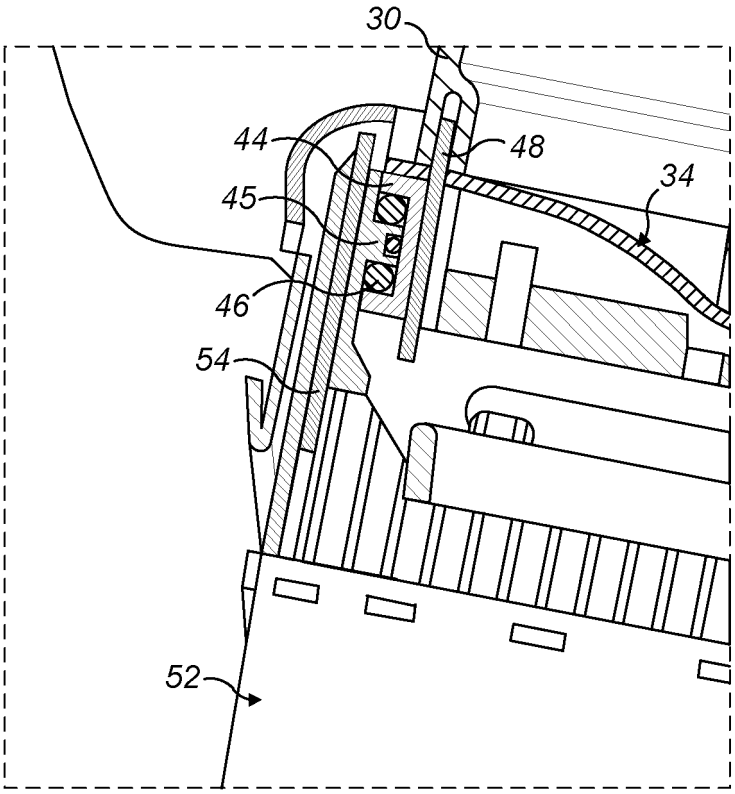

FIG. 3A

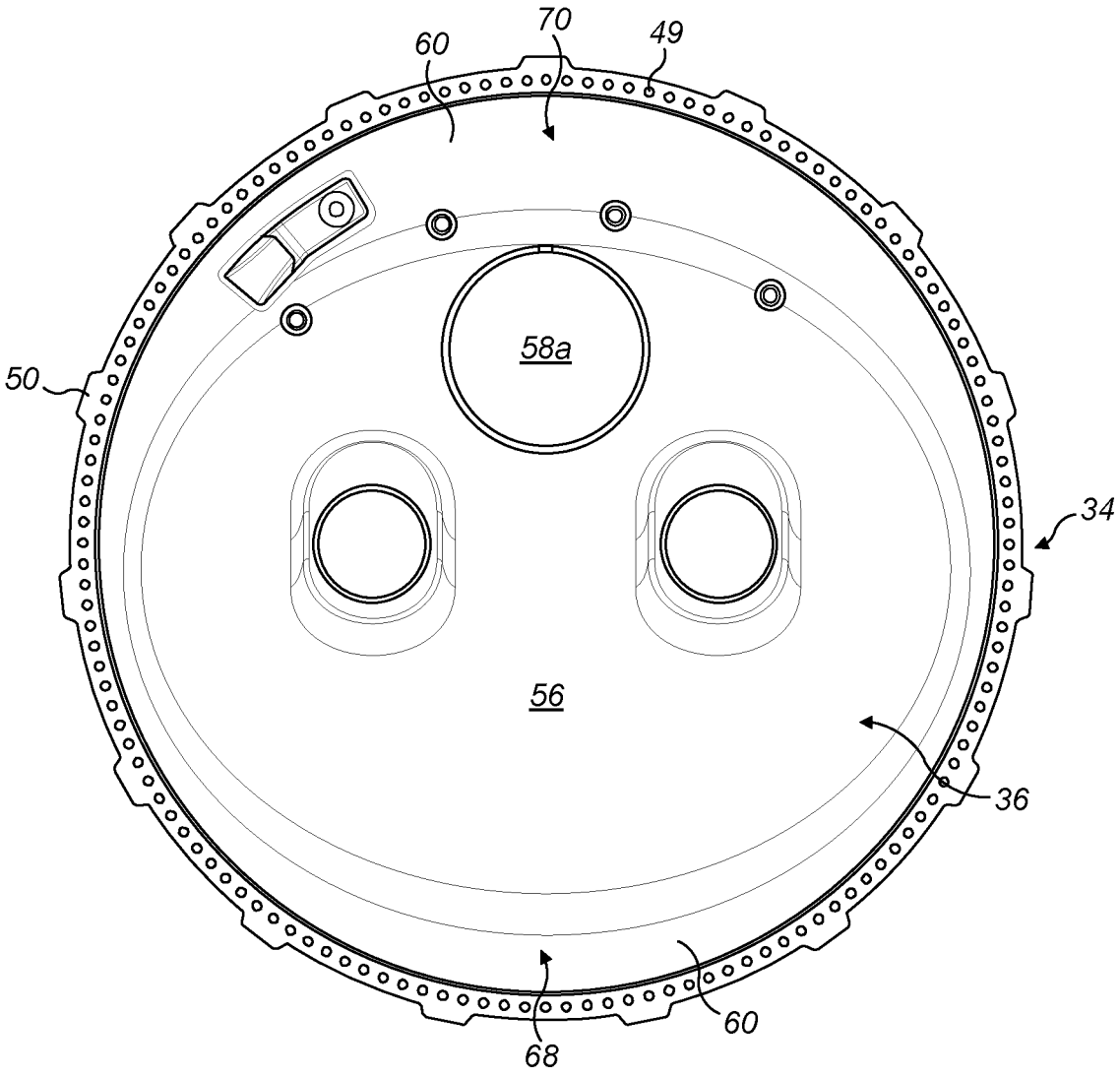

FIG. 4

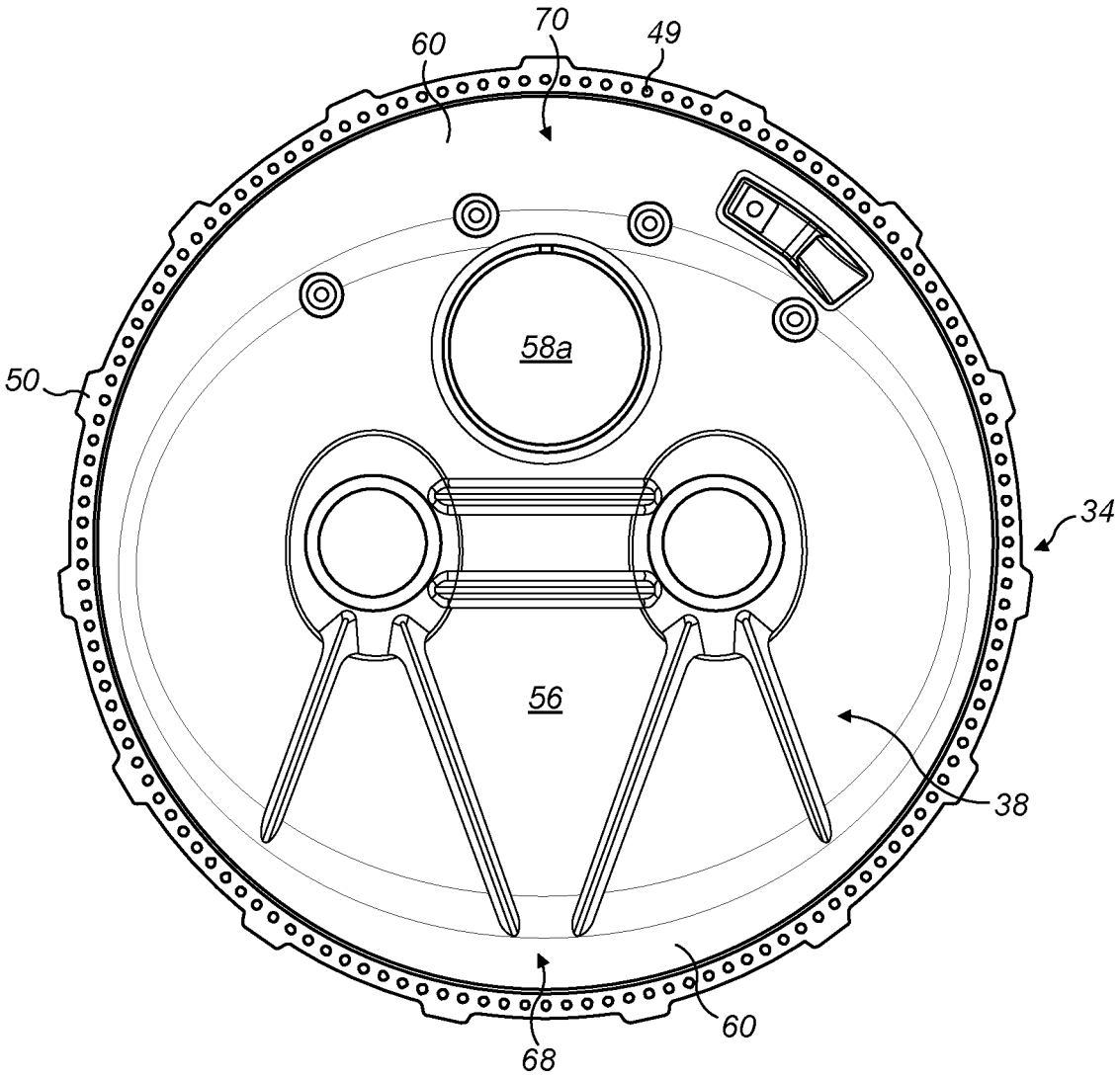

FIG. 5

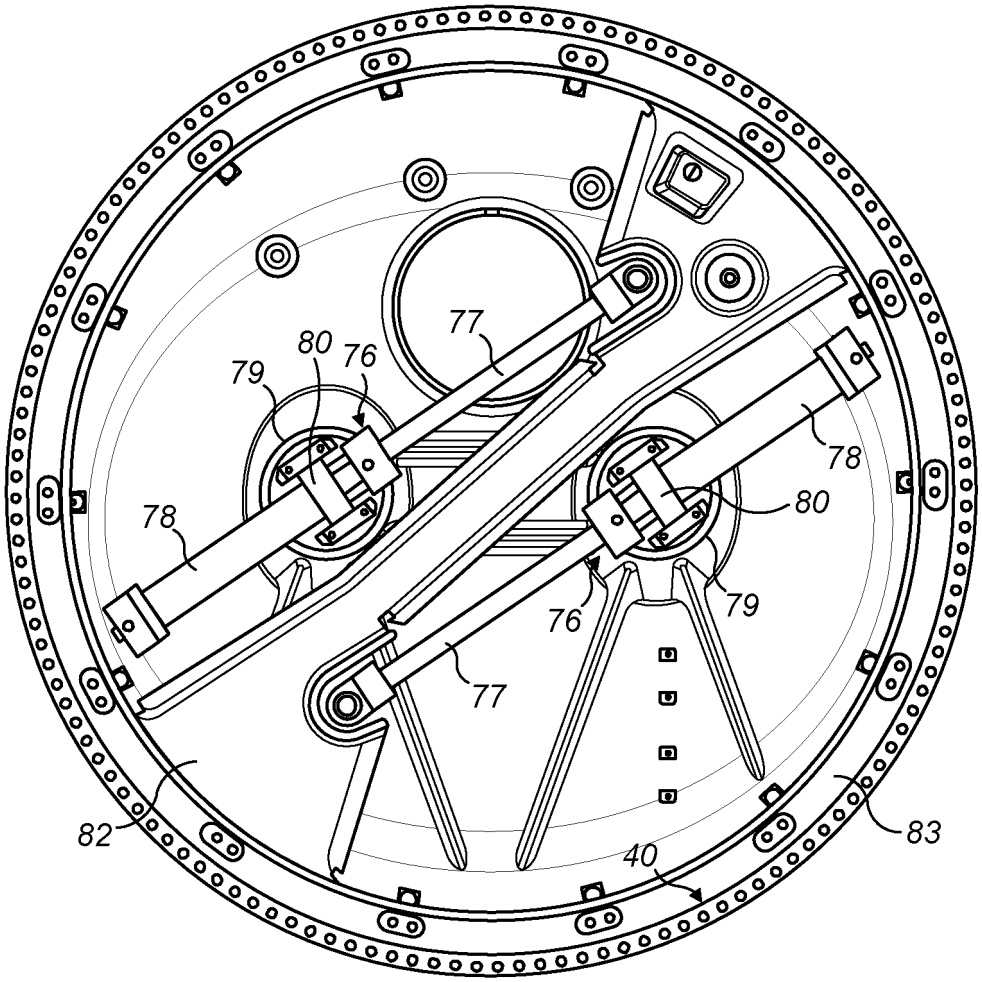

FIG. 6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- DE 202004003521 U1 **[0008]**
- EP 1930584 A2 **[0008]**